

# PRIVATE BRANCH EXCHANGE SYSTEM

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention:

5       The present invention relates to a private branch exchange system, and more particularly to a private branch exchange system using a plurality of mobile stations.

### 2. Description of the Related Art:

10       Conventionally, in a private branch exchange system, one department is assigned one or a plurality of extension numbers which are used to make a wired-based call on the premises.

15       However, in such a private branch exchange system, since one department is simply assigned one or a plurality of extension numbers, a telephone call intended for a user belonging to the department may be answered by another user. In this case, extra time is required for putting the intended user on the line.

20       Additionally, when a called party is away from his desk, a calling party must make a call again.

25       To address these disadvantages, in recent years, a private branch exchange system is contemplated in which each user of the private branch exchange system is assigned one mobile station for performing wireless communication. It is thus possible to eliminate the time

taken for putting an intended user on the line

and to receive an incoming call even when a user is away from his desk.

Mobile stations assigned to respective users have different extension numbers respectively which are used to make a call among the mobile stations.

In the prior art private branch exchange system using mobile stations as mentioned above, each user of the private branch exchange system is assigned one mobile station having a unique extension number, so that a common extension number throughout one department is not provided as in the prior art wired private branch exchange system.

Thus, in the case of a call directed to a department, a mobile station is called by using an extension number of one of users belonging to the department. If the mobile station is busy or outside a service area, a disadvantage occurs in that another mobile station is called by using an extension number of another user belonging to the department.

Additionally, a disadvantage exists in that, if a mobile station is busy, a caller must make another call later since one mobile station is assigned only one extension number.

When a mobile station is busy or outside a service area, a call directed thereto may be transferred to

another mobile station. However, the transfer function depends on the setting operations by a user, and the disadvantages as mentioned above occur if a user has forgotten to set the transfer function.

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#### SUMMARY OF THE INVENTION

It is an object of the present invention to provide a private branch exchange system which assigns a plurality of extension numbers to a plurality of mobile stations to reduce the frequency with which a call is again originated and to allow services similar to those of a wired private branch exchange system.

In the present invention, a plurality of extension numbers including at least one unique extension number are provided for each of a plurality of mobile stations, and different lines are set for the respective extension numbers. Thus, even when one line is used for a call, another line can be used to make another call.

When at least one of a plurality of extension numbers set for a plurality of mobile stations is a common extension number to the mobile stations in the same department, a caller may call that extension number if he attempts to call the department, which translates into a call to a mobile station of any one of users belonging to the department. In this manner, services similar to those in the wired prior art private branch

exchange system can be provided.

When each of a plurality of mobile stations is provided with a transfer function for transferring an incoming call at a line to another line, a call can be received even when another call is in progress if previous setting is performed such that an incoming call at a line during use for another call is transferred to another line.

The above and other objects, features, and advantages of the present invention will become apparent from the following descriptions with reference to the accompanying drawings which illustrate examples of the present invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram showing an embodiment of a private branch exchange system of the present invention;

Fig. 2 is a diagram for explaining an arrangement of a mobile station shown in Fig. 1;

Fig. 3 is a diagram showing a data arrangement managed by a data managing section shown in Fig. 1;

Fig. 4 is a diagram showing a format of a signal sent from a mobile station to an exchange station when a line key or reserve button shown in Fig. 2 is pressed;

Fig. 5 is a diagram for explaining an example of call control operations in the private branch exchange

system shown in Fig. 1 to Fig. 4;

Fig. 6 is a diagram for explaining an example of call control operations in the private branch exchange system shown in Fig. 1 to Fig. 4;

5 Fig. 7 is a diagram for explaining an example of call control operations in the private branch exchange system shown in Fig. 1 to Fig. 4; and

Fig. 8 is a diagram for explaining an example of call control operations in the private branch exchange  
10 system shown in Fig. 1 to Fig. 4.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Fig. 1, the present embodiment comprises a plurality of mobile stations 10a to 10c, base  
15 station 20 wirelessly connected to mobile stations 10a to 10c, and exchange station 30 for performing call control of mobile stations 10a to 10c through base station 20. Each of mobile stations 10a to 10c has a plurality of extension numbers including a unique extension number and  
20 other extension numbers, thereby allowing the setting of a plurality of telephone lines. It should be noted that a line set with a unique extension number is referred to as a "personal line" in a mobile station, and lines set with other extension numbers are referred to as  
25 "sublines" in the mobile station. For example, as extension numbers for setting personal lines, number 2000

is set for mobile station 10a, number 3000 for mobile station 10b, and number 4000 for mobile station 10c. As an extension number for setting a subline, number 5000 is set in common for mobile stations 10a to 10c to allow the number 5000 to be used as a common extension number of mobile stations 10a to 10c. Alternatively, as extension numbers for setting sublines, number 5000 is set in common for mobile stations 10a and 10b, and number 6000 is set for mobile station 10c unlike mobile stations 10a and 10b, so that mobile station 10c has two set extension numbers not in common with other mobile stations 10a and 10b.

When one mobile station has two extension numbers not in common with other mobile stations as mentioned above, the two numbers can be individually used such that the one is sending is transmitting and the other is to reception.

Mobile stations 10a to 10c are provided with a transfer function (not shown). When one mobile station has two extension numbers not in common with other mobile stations as mentioned above, a call can be received even when another call is in progress if previous setting is made such that an incoming call at a line during use for another call is transferred to another line.

Provided in CPU 31, serving as control means for controlling the operations of exchange station 30, has a

control section 32, data managing section 33, line state control section 34 and managing section 35.

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5 Control section 32 performing call control of mobile stations 10a to 10c, data managing section 33 managing information for each extension number managed in the private branch exchange system, line state managing section 35 managing the states of telephone lines in the private branch exchange system, and line state control section 34 controlling the states of telephone lines  
10 using the information managed by data managing section 33 and line state managing section 35 based on the operations at mobile stations 10a to 10c.

While one base station 20 and three mobile stations 10a to 10c are provided in Fig. 1, the numbers of the  
15 base station and the mobile stations are not limited thereto.

As shown in Fig. 2, each of mobile stations 10a to 10c in the embodiment is provided with numeric keypad 11 for input of data such as numerals, line keys 12 for  
20 setting a telephone line for each extension number possessed by mobile stations 10a to 10c, reserve button 13 for suspending a call, end key 14 for terminating a call, display portion 15 for displaying information, microphone 16 for receiving voice information, and  
25 speaker 17 for outputting voice information.

Each of mobile stations 10a to 10c has keys in line

keys 12 corresponding to the number of extension numbers possessed by the mobile station (in the embodiment, the total number n of line key L1 for setting a personal line and line keys L2 to Ln for setting sublines). The pressing of an appropriate key allows a call to be made using a line corresponding to the key.

As shown in Fig. 3, data managing section 33 manages data which comprises extension number 101 managed by the private branch exchange system, line identification information 102 for identifying if extension number 101 is for setting a personal line or a subline, and mate line list 103 which, if extension number 101 is an extension number for setting a personal line, stores an extension number provided for setting a subline in a mobile station which uses the former extension number to set its personal line, and which, if extension number 101 is an extension number for setting a subline, stores an extension number provided for setting a personal line in a mobile station which uses the former extension number to set its subline. The number of sets of such stored data is equal to the number of extension numbers managed by the private branch exchange system.

As shown in Fig. 4, when line key 12 or reserve button 13 of one of mobile stations 10a to 10c (see Fig. 1) is pressed, exchange station 30 (see Fig. 1) is provided with a signal comprising pressed button type 201



for indicating the type of the pressed button and personal line extension number 202 for setting a personal line of the one of mobile stations 10a to 10c (see Fig. 1) whose button has been pressed.

5       Description will be hereinafter made for call control operations in the private branch exchange system configured as described above with reference to Fig. 1 and Fig.2.

10       First, operations in the case of originating a call using a personal line in mobile stations 10a to 10c with no call present in mobile stations 10a to 10c are described using an example where mobile station 10a originates a call to mobile station 10b.

15       When an extension number of mobile station 10b which is a called party is input through numeric keypad 11 of mobile station 10a, the inputxted extension number is sent to exchange station 30 through base station 20. Thereafter, call control section 32 in exchange station 30 performs call origination processing on mobile station 20 10b having the sent extension number.

25       Next, operations for receiving a call at a personal line of mobile stations 10a to 10c with no call present in mobile stations 10a to 10c are described using an example of operations for receiving a call at a personal line of mobile station 10c.

When no call is present at mobile station 10c, the

call reception at the personal line of mobile station 10c is made such that call control section 32 in exchange station 30 performs call origination processing based on the manipulations at calling mobile station 10a or 10b to  
5 achieve the call reception at the personal line of mobile station 10c.

Next, operations when line key 12 or reserve button 13 is pressed at one of mobile stations 10a to 10c with a call present in the one of mobile stations 10a to 10c are  
10 described using an example where line key 12 or reserve button 13 is pressed at mobile station 10a.

When line key 12 or reserve button 13 is pressed at mobile station 10a with a call present at mobile station 10a, such information as shown in Fig. 4 is sent from  
15 mobile station 10a to exchange station 30 through base station 20.

The information sent to exchange station 30 is sent to line state control section 34 through call control section 32 in exchange station 30.

20 Line state control section 34 extracts all the extension numbers set for mobile station 10a from the data managed by data managing section 33 based on the information sent from mobile station 10a.

Next, line state control section 34 extracts the  
25 states of the lines set with the extension numbers extracted from data managing section 33 from the

information managed by line state managing section 35.

Thereafter, line state control section 34 selects call processing based on the states of the lines extracted from line state managing section 35 and the type of the pressed button sent from mobile station 10a, and call control section 32 performs the call processing selected by line state control section 34.

In the following, the aforementioned operations are described with specific examples.

First, description is made for the operations when mobile station 10a suspends its personal line set with line key L1 during a call using the personal line to originate a call using a subline set with line key L2, with reference Fig. 5.

When reserve button 13 is pressed at mobile station 10a during a call using the personal line set with line key L1, such information as shown in Fig. 4 is sent from mobile station 10a to exchange station 30 through base station 20. In this case, pressed button type 201 shown in Fig. 4 is the reserve button, and an associated extension number is the extension number for setting the personal line at mobile station 10a.

The information sent to exchange station 30 is sent to line state control section 34 through call control section 32 in exchange station 30.

Then, line state control section 34 extracts all

the extension numbers set for mobile station 10a from the data managed by data managing section 33 based on the information sent from mobile station 10a. Specifically, all the extension numbers for setting sublines stored in  
5 mate line list 103 accompanied with the extension number for setting the personal line at mobile station 10a are extracted.

Next, line state control section 34 extracts the states of the lines set with the extension numbers  
10 extracted from data managing section 33 from the information managed by line state managing section 35. In this case, the extracted information includes "communicating" for L1 and "empty" for other lines.

Next, line state control section 34 selects call  
15 processing based on the states of the lines extracted from line state managing section 35 and pressed button type 201 sent from mobile station 10a. In this case, since pressed button type 201 is the reserve button, it is determined that a user of mobile station 10a desires  
20 to suspend a call.

Thereafter, call control section 32 performs call suspending processing set with line key L1 under the control of line state control section 34, thereby suspending the call set with line key L1.

25 After the call is suspended, when line key L2 is pressed at mobile station 10a, such information as shown

in Fig. 4 is sent from mobile station 10a to exchange station 30 through base station 20. In this case, pressed button type 201 shown in Fig. 4 is L2 button and an associated extension number is the extension number  
5 for setting the personal line at mobile station 10a.

The information sent to exchange station 30 is sent to line state control section 34 through call control section 32 in exchange station 30.

Then, line state control section 34 extracts all  
10 the extension numbers set for mobile station 10a from the data managed by data managing section 33 based on the information sent from mobile station 10a. Specifically, all the extension numbers for setting sublines stored in mate line list 103 accompanied with the extension number  
15 for setting the personal line at mobile station 10a are extracted.

Next, line state control section 34 extracts the states of the lines set with the extension numbers extracted from data managing section 33 from the  
20 information managed by line state managing section 35. In this case, the extracted information includes "suspending" for L1 and "empty" for other lines.

Next, line state control section 34 selects call processing based on the states of the lines extracted  
25 from line state managing section 35 and pressed button type 201 sent from mobile station 10a. In this case,

since pressed button type 201 is L2 button, it is determined that the user of mobile station 10a desires to originate a call using the line set with line key L2.

Thereafter, call control section 32 performs call  
5 originating processing set with line key L2 under the control of line state control section 34, thereby originating a call set with line key L2.

Next, description is made for the operations when a user receives an incoming call at mobile station 10a  
10 through a subline set with line key L2 during a call using a personal line set with line key L1 and then answers the incoming call of the subline set with line key L2 without suspending the personal line, with reference Fig. 6.

When an incoming call occurs at the subline set  
15 with line key L2 of mobile station 10a during a call using the personal line set with line key L1 at mobile station 10a, the incoming call is notified from call control section 32 in exchange station 30 to mobile  
20 station 10a through base station 20.

The aforementioned incoming call is also notified from call control section 32 to line state control section 34 which rewrites the state of a line set with line key L2 of mobile station 10a out of lines managed by  
25 line state managing section 35.

Thereafter, line key L2 is pressed at mobile

station 10a, such information as shown in Fig. 4 is sent from mobile station 10a to exchange station 30 through base station 20. In this case, pressed button type 201 shown in Fig. 4 is L2 button, and an associated extension  
5 number is the extension number for setting the personal line at mobile station 10a.

The information sent to exchange station 30 is sent to line state control section 34 through call control section 32 in exchange station 30.

10 Then, line state control section 34 extracts all the extension numbers set for mobile station 10a from the data managed by data managing section 33 based on the information sent from mobile station 10a. Specifically, all the extension numbers for setting sublines stored in  
15 mate line list 103 accompanied with the extension number for setting the personal line at mobile station 10a are extracted.

Next, line state control section 34 extracts the states of the lines set with the extension numbers  
20 extracted from data managing section 33 from the information managed by line state managing section 35. In this case, the extracted information includes "communicating" for L1, "receiving" for L2, and "empty" for other lines.

25 Next, line state control section 34 selects call processing based on the states of the lines extracted

from line state managing section 35 and pressed button type 201 sent from mobile station 10a. In this case, since pressed button type 201 is L2 button, it is determined that a user of mobile station 10a desires to  
5 disconnect the communication using the line set with line key L1 to answer the incoming call through the line set with line key L2.

Thereafter, call control section 32 performs processing for disconnecting the communication using the  
10 line set with line key L1 and response processing to the incoming call through the line set with line key L2 under the control of line state control section 34, thereby responding to the incoming call through the line set with line key L2.

15 In this manner, line state control section 34 may cause call control section 32 to perform a plurality of call control processing for one event.

Next, description is made for the operations when an incoming call occurs at a subline of mobile stations  
20 10a to 10c and mobile station 10a answers the incoming call.

When an incoming call directed to a subline occurs in call control section 32 in exchange station 30, call control section 32 transmits a notification of subline  
25 call reception to line state control section 34.

Then, line state control section 34 extracts all



the extension numbers set for personal lines of mobile stations 10a to 10c which have the extension number specified by a calling mobile station for setting a subline from the data managed by data managing section 33.

5 Specifically, in the data as shown in Fig. 3 managed by data managing section 33, all the extension numbers for setting the personal lines of mobile stations 10a to 10c which have the extension number specified by the calling mobile station for setting a subline are extracted from  
10 mate line list 103 accompanied with extension number 101 being the extension number specified by the calling mobile station.

Next, the state of the line of the subline specified by the calling mobile station is rewritten to  
15 "receiving" out of the lines managed by line state managing section 35.

Line state control section 34 sends to call control section 32, based on the extension numbers extracted from the data managing section 33, a direction for sending a  
20 subline reception signal to mobile stations 10a to 10c which have the extension number for setting its personal line.

Thereafter, call control section 32 notifies the subline reception to mobile stations 10a to 10c which  
25 have the extension number extracted from data managing section 33.

When line key L2 for setting that subline is pressed at mobile station 10a of mobile stations 10a to 10c which have been notified of the subline reception, such information as shown in Fig. 4 is sent from mobile station 10a to exchange station 30 through base station 20. In this case, pressed button type 202 shown in Fig. 4 is L2 button, and an associated extension number is the extension number for setting the personal line at mobile station 10a.

10 The information sent to exchange station 30 is sent to line state control section 34 through call control section 32 in exchange station 30.

Line state control section 34 extracts all the extension numbers set for mobile station 10a from the data managed by data managing section 33 based on the information sent from mobile station 10a. Specifically, all the extension numbers for setting sublines stored in mate line list 103 accompanied with the extension number for setting the personal line at mobile station 10a are extracted.

Next, line state control section 34 extracts the states of the lines set with the extension numbers extracted from data managing section 33 from the information managed by line state managing section 35. In this case, the extracted information includes "receiving" for L2, and "empty" for other lines.

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Next, line state control section 34 selects call processing based on the states of the lines extracted from line state managing section 35 and pressed button type 201 sent from mobile station 10a. In this case, 5 since pressed button type 201 is L2 button, it is determined that a user of mobile station 10a desires to answer the incoming call through the line set with line key L2.

Thereafter, call control section 32 performs 10 response processing to the incoming call through the line set with line key L2 under the control of line state control section 34, thereby responding to the incoming call through the line set with line key L2.

Next, description is made for the operations when a 15 user suspends a call at mobile station 10a and then takes the call again at another mobile station 10b to continue the communication, with reference to Fig. 8.

When reserve button 13 is pressed during a call using a subline set with line key L2 at mobile station 20 10a, such information as shown in Fig. 4 is sent from mobile station 10a to exchange station 30 through base station 20. In this case, pressed button type shown in Fig. 4 is the reserve button, and an associated extension number is the extension number for setting the personal 25 line at mobile station 10a.

The information sent to exchange station 30 is sent

to line state control section 34 through call control section 32 in exchange station 30.

Line state control section 34 extracts all the extension numbers set for mobile stations 10a from the data managed by data managing section 33 based on the information sent from mobile station 10a. Specifically, all the extension numbers for setting sublines stored in mate line list 103 accompanied with the extension number for setting the personal line at mobile station 10a are extracted.

Next, line state control section 34 extracts the states of the lines set with the extension numbers extracted from data managing section 33 from the information managed by line state managing section 35. In this case, the extracted information includes "communicating" for L2, and "empty" for other lines.

Next, line state control section 34 selects call processing based on the states of the lines extracted from line state managing section 35 and pressed button type 201 sent from mobile station 10a. In this case, since pressed button type 201 is the reserve button, it is determined that a user of mobile station 10a desires to suspend a call.

Thereafter, call control section 32 performs suspending processing of the call set with line key L2 under the control of line state control section 34,

thereby suspending the call set with line key L2.

When line key L2 is pressed at mobile station 10b which can set the line with line key L2 similarly to mobile station 10a in a state where the call set with  
5 line key L2 at mobile station 10a is suspended, such information as shown in Fig. 4 is sent from mobile station 10b to exchange station 30 through base station 20. In this case, pressed button type 201 shown in Fig. 4 is L2 button, and an associated extension number is the  
10 extension number for setting the personal line at mobile station 10b.

The information sent to exchange station 30 is sent to change state control section 34 through call control section 32 in exchange station 30.

15 Line state control section 34 extracts all the extension numbers set for mobile stations 10b from the data managed by data managing section 33 based on the information sent from mobile station 10b. Specifically, all the extension numbers for setting sublines stored in  
20 mate line list 103 accompanied with the extension number for setting the personal line at mobile station 10b are extracted.

Next, line state control section 34 extracts the states of the lines set with the extension numbers  
25 extracted from data managing section 33 from the information managed by line state managing section 35.

In this case, the extracted information includes  
"suspending" for L2, and "empty" for other lines.

Next, line state control section 34 selects call  
processing based on the states of the lines extracted  
5 from line state managing section 35 and pressed button  
type 201 sent from mobile station 10b. In this case,  
since pressed button type 201 is L2 button, it is  
determined that a user of mobile station 10b desires to  
restart the communication using the line set with line  
10 key L2.

Thereafter, call control section 32 performs  
processing for originating the call set with line key L2  
under the control of line state control section 34,  
thereby restarting the communication of the call set with  
15 line key L2.

#### (Other Embodiments)

While an extension number is common only to a  
plurality of mobile stations in the aforementioned  
20 embodiment, a general wired extension may be set for a  
mobile station to realize a private branch exchange  
system which also serves as a general wired extension.

Thus, when a user during a call using a general  
extension desires to move to a different location with  
25 the call maintained, the user may once suspend the call  
using the general extension and then restart the call at

[illegible]

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